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For a Higher Sprint Running Performance, in Which Part of the Warm-Up Protocol Should the Dynamic Stretching Phase be Applied?

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Abstract

The literature has frequently examined the acute effect of warm-up protocols on athletic performance components. The lack of evidence in static stretching studies led researchers to dynamic stretching protocols that simultaneously enhance basic skill level, kinaesthetic awareness, range of motion, and core temperature. However, it needed to be clarified in which part of the warming up the dynamic stretching phase should be done. This study investigated the acute effect of the dynamic stretching exercise phase before and after a warm-up on the 20m sprint performance. The study included forty-four soccer players, aged 16.59±1.06 years, who played for amateur teams. Participants were randomly divided into two groups on the first day of the study. In the first group, dynamic stretching was performed before warm-up (BGW), and the players' 20m sprint performances were tested. In the second group, dynamic stretching was performed after the warm-up (AGW), and the players' 20m sprint performances were tested. On the second day of the study, the same protocol was applied to the same players by changing groups of players. The average speed in the 20m sprint test of the BGW group (2.96±0,13 sec.) was found to be significantly shorter than the AGW group (3.01±0,12 sec., $p<0.05$). The difference in the 20 m speed test values between groups was significant ($p<0.05$). The findings obtained in the applied experimental condition show that the dynamic stretching protocol applied before the warm-up running phase increases the sprint running performance. It may be more beneficial for the performance of athletes to do dynamic stretching before sprint running performances.

Keywords: Sprint Performance, Dynamic Stretching, Warm-up protocol, Running Speed

INTRODUCTION

The development of short-distance sprint (short-sprint) performance (i.e., 5–20 m) is a vital component of the athletic performance of football players (1). One of the key factors of success in speed and power-based sports is to apply a good warm-up routine before the performance (1-3). When the emergence of warming routines is examined, it can be observed that the warming components are formed more conventionally than they are applied according to scientific evidence (1, 3). Generally, the warm-up section consists of a general warm-up, stretching-mobility phases, sport-specific movements, and activation sections (4, 5). Planning a good warm-up routine considers duration, content, intervals, intensity, and how long before the performance did. Recently, researchers have been especially focused on the acute effects of static and dynamic stretching in the content title and discussed their effects on athletic performance and their physiological dimensions (6). Interestingly, there is no information on which part of the warm-up dynamic stretching phase applications acutely produces higher performance output.

The movements applied during dynamic stretching activate the integrity of the muscle, ligament, and joint (7). The applied movements are generally in the form of specific movement patterns or similar forms belonging to the sports branch. These aspects activate skeletal musculature and other related systems (8, 9). The movements are performed repeatedly with a dynamic relaxation phase after a short stretching phase. The applied movements should be performed in a fluent tempo, rhythmically (2 seconds of a stretch: 2 seconds of relaxation or 4:4 or 2:4) and with high movement quality. The total number of moves is between 4 and 10. 2-4 sets of 8-16 repetitions are performed in 5-12 minutes. Such applications generally lead to physiological responses such as increased cardiac output and intramuscular and core body temperature. (10-12). The increase in temperature in the muscle causes a decrease in muscle viscosity, and the decrease in viscosity causes an increase in the range of motion of the joint. In addition, acute improvement of muscle coordination with the specific movement patterns applied increases the muscle-reflex activation in the working muscle with the firing and synchronization of motor units. In addition, the specific movement patterns are applied to increase the muscle-reflex activation in the working muscle, improving acute muscle coordination, firing, and synchronization of motor units. Recent reports show that dynamic stretching creates a post-activation potential associated with stimulating the motor units of type 2 muscle fibres (10-12).

During a sprint performance, alactic anaerobic energy pathways dominate, and a high involvement of Type 2 muscle fibres is observed with a high motor unit firing (13, 14). Meanwhile, the Stretch-shortening cycle takes place at a very high speed. Stimulation of these mechanisms is an important prerequisite in the warm-up routine. Short sprints at high speeds are commonly used in the warm-up routine to achieve this. Several studies suggest that dynamic stretching has a greater positive effect on sprint performance and stretching procedures than static stretching (8, 9). However, few studies have reported negative effects (15, 16). In this regard, we hypothesized that the dynamic stretching phase performed prior to the general warm-up would improve sprint performance. The study aims to investigate which part of the warm-up protocol dynamic stretching phase should be applied for a higher sprint running performance.

MATERIAL AND METHOD

Participants

Forty-four male, healthy football players (16.5 ± 1 age, 1.72 ± 7.4 cm height, and 61.7 ± 7.7 kg weight) who played in regional football leagues participated in the study. The average training history of the participants is 4.5 years. The subjects had no neurologic, medical, or cardiovascular disease symptoms and were not taking any medications. The sample size was calculated with the GPower 3.1.9.4 program. Accordingly, the sample size was 44 participants with an alpha (mistake) rate of 5% and 95% power with a medium effect size for the dependent t-test. All subjects were informed about the procedures, and each gave written consent. The Ethics Committee of Dokuz Eylül University approved all procedures and the experimental design (2018/19-13). The study protocol conformed to the guidelines of ethical principles of the Declaration of Helsinki, and the aims and risks of the study were understood before the beginning of the study by all participants and their parents who signed informed consent.

Experimental Design

The experiments of the study were completed in three days. On the first day of the study, the participants were informed in detail about the research. Then, anthropometric measurements [height, body weight, muscle mass, and fat percentage were made with a bioelectrical impedance device; Biospace Inbody, Seoul, Korea; (17)] and maximum oxygen consumption values were measured. The participants were randomly divided into 2 groups on the second day of the study. Group 1 performed dynamic stretching before the general warming phase (BGW; Figure 3). The second group performed dynamic warming after the general warming phase (AGW; Figure 3). On the 2nd and 3rd test days, both groups performed 20 meters of sprint performance after two different conditions (Figure 1). All warm-up exercises and measurements were carried out by researchers at the same hours (5.00 PM). The subjects were asked to refrain from caffeine intake on each testing day and avoid food consumption 2 hours before testing. The subjects were encouraged to drink ad libitum to ensure adequate hydration status.

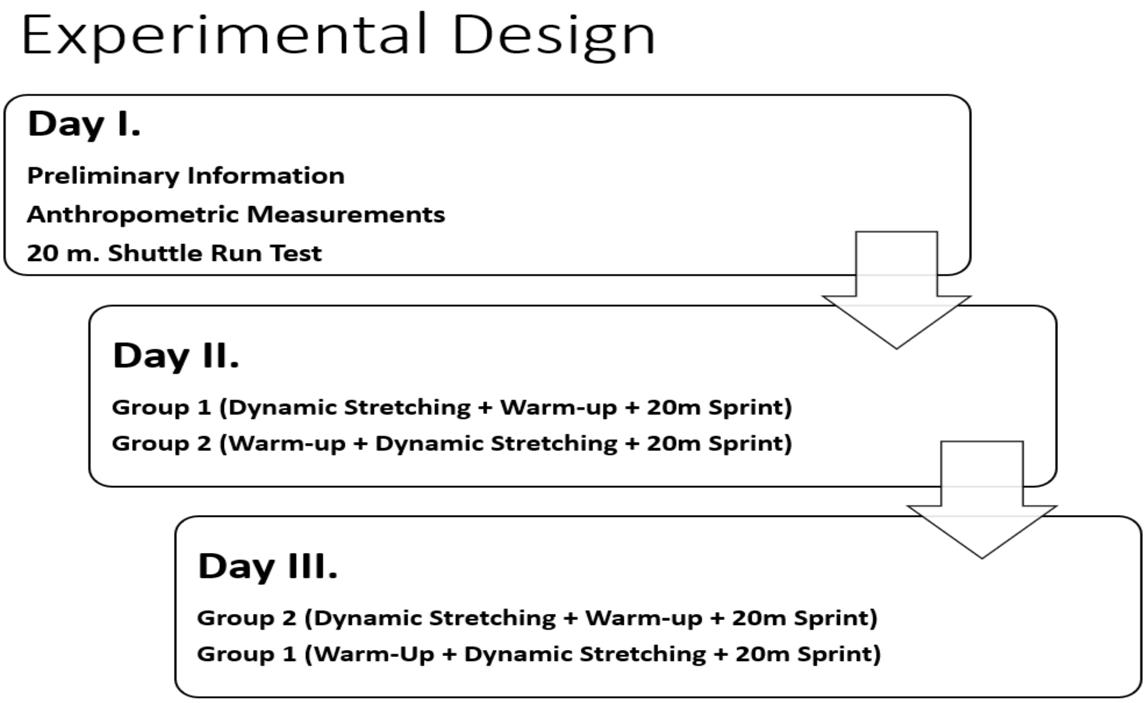

Figure 1: Experimental Design

20m. Shuttle Run Test (VO_2 Max)

Participants were instructed to run back and forth between two lines 20 meters apart, with a running velocity determined by audio signals (18). Starting speed was 8.5 km/h, and every minute (stage), the speed was increased by 0.5 km/h until the subject could no longer keep pace with Physical Workload and Work Capacity and did not reach the lines in time twice in a row. The test result corresponded to the number of reached stages and shuttles and was used to predict VO_2Max according to a validated table.

General Warm-up Protocol

Adhering to the classical warm-up method, a warm-up run was applied at low-intensity aerobic speeds for an average of 5 minutes at an individual pace. In the protocol context, a 2 x 10 meters sprint was applied to increase neuromuscular stimulation toward the end.

Dynamic Stretching Protocol

The dynamic stretching protocol was created from 6 basic exercises for the hamstring, quadriceps, and hip extensor muscles used during the sprint. The movements were performed in 14 repetitions for each dynamic stretching exercise. The movements were smoothly applied at a 2: 2 tempo, moderate stretches were applied, and walking intervals of three steps were given during the relaxation phase. 10 seconds of rest in between movements was applied. The protocol was completed in about 5 minutes (Figure 2).

Figure 2: Dynamic Stretching Protocol (Respectively; Standing quadriceps stretching, standing knee pull, Hip internal rotation, Hip external rotation, standing hamstring stretching, Standing toe touch)

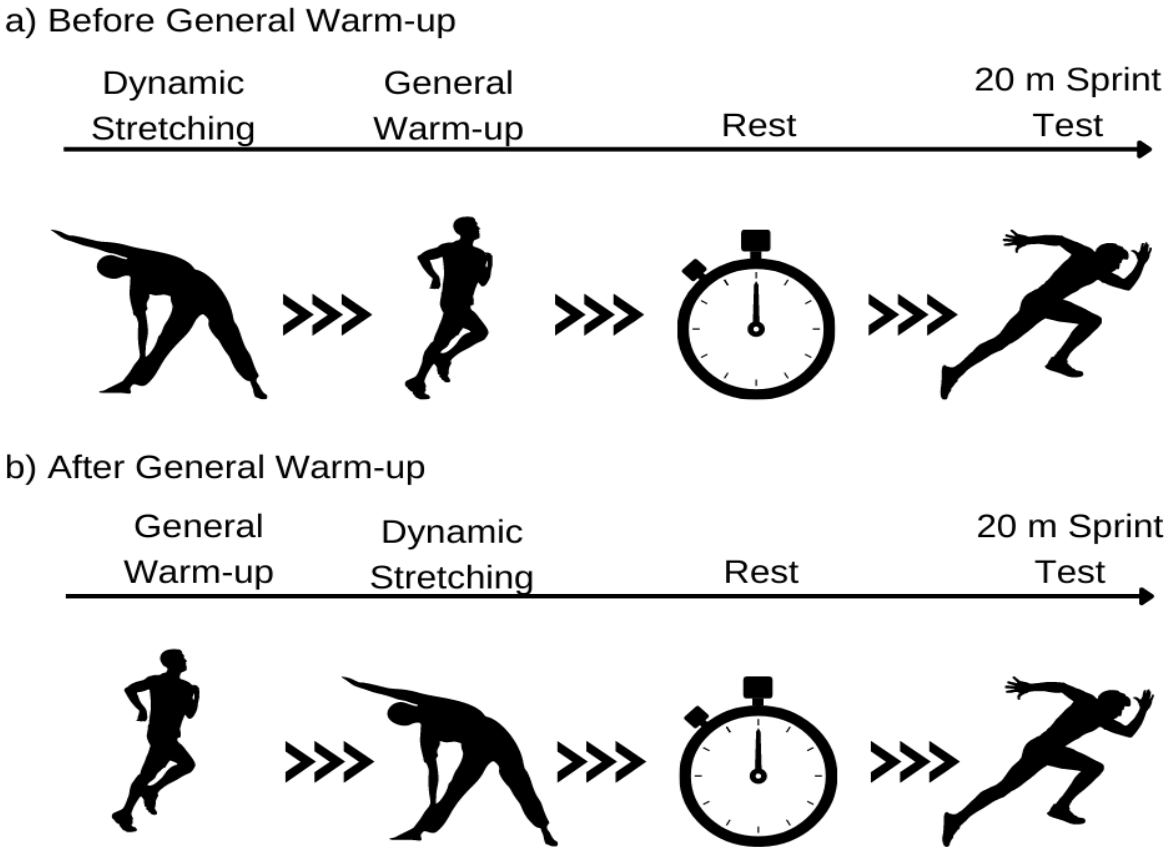

Figure 3: Warm-up Strategies a) Before General Warm-up Protocol, b) After General Warm-up Protocol

20m. Sprint Running Protocol

Test conducted in windless weather and synthetic ground. Participants wore the same and soccer-specific standard shoes to each testing session. Running times were recorded with the "Newtest Powertimer 300-series" device (Newtest Powertimer 300-series, Oulu, Finland; 19), which had previously determined the validity and reliability of the Enoksen., and Tonnessen., (2009). Photocells connected to a two-beam single photoelectric gate were placed 20 m apart. The participants started 0.3 m behind the 1st beams, which were placed at a 0.3-m height and the last pairs of beams were placed at a 0.7-m height to avoid the participants throwing their arms or legs forward to get a faster time. The participants began trials in their own time, from a standing start of 0.3 m behind the first timing gate to avoid any reaction time effect, which could be because of a starter's instruction, and also to avoid triggering the electronic gate prematurely. No feedback was provided to the subjects who were given standard track and field instructions during the experimental conditions. tried to apply their maximum performance in the test.

Statistical Analysis

The data were evaluated with the SPSS 22.0 package program. Shapiro-Wilk tests were used to control the normality of the data. All of the data were distributed normally. Pre and Post measurements of the groups were tested via Dependent Groups T-Test. A Variance Analysis test was used to compare the differences between groups. The level of significance was set at $p < 0.05$. The effect size was calculated with the Cohen d formula. 0.20 was considered a small effect, 0.50 a medium effect, 0.80 a large effect, and 1.30 and above as a very large effect (20).

RESULTS

Forty-four male healthy football players who played in regional football leagues participated in the study (1.72 ± 7.4 cm height, 61.7 ± 7.7 kg weight, 16 ± 1 year, 20.6 ± 1.7 BMI, 31 ± 4.1 kg Muscle Mass, 6.5 ± 2.4 kg Fat Mass, and 48.8 ± 4.5 ml/kg/min VO2 Max). The average of the 20m speed performance of the groups tested BGW and AGW exercises are given in Table 1.

Table 1. 20 m sprint performances results according to test days

	Groups (n:44)	N	Mean ± SD
First Test Day	**BGW**	26	2,99 ± 0,1
	AGW	18	3,08 ± 0,1
Second Test Day	**BGW**	18	2,91 ± 0,1
	AGW	26	2,96 ± 0,1

BGW: before the general warming, AGW: after the general warming, SD: standard deviation

The sprint times of the group that performed BGW were found to be significantly shorter (Table 2; $p < 0.05$).

Table 2. 20 m sprint performances of BGW and AGW groups

Groups (n:44)	Mean ± SD (sec.)	Sig.(p)	Effect Size (Cohen's d)
BGW Running Time	2,96 ± 0,1	0,033 *	0.9 (large effect)
AGW Running Time	3,01 ± 0,1		

BGW: before the general warming, AGW: after the general warming, SD: standard deviation
*p< 0.05

DISCUSSION

The study investigated the acute effect of applying the dynamic stretching phase in different warm-up parts on 20-meter sprint performance. The study's key finding is that conducting dynamic stretching exercises before the general warm-up improves acute 20-meter sprint performance.

A classical warm-up procedure generally includes low-intensity aerobic exercise (jogging or running), followed by a series of static & dynamic stretching routines, and finishes with sport-specific movement patterns. Recently cumulative research results suggested a negative impact of acute static stretching on subsequent sprint running performance (21-24). Otherwise, many research data showed that dynamic stretching enhances sprint running performance (25, 26). Although the duration of the dynamic stretching routine is related to the intensity and volume of the stretching movements (25, 27), it has been reported that the most optimal routine consists of one or two sets of 12 movements performed at a fluent tempo (28). 20 meters sprint performance requires high acceleration skills. Ground reaction force (29), muscle temperature, type 2 a-b motor unit recruitment, synchronization, running mechanic, technique, step frequency, and distance all play important roles in the development of this acceleration. Stimulation of all physiological components during the warm-up phase can directly impact sprint performance. Different parts applied during the warm-up affect these physiological mechanisms at different levels. More metabolic gains can be achieved in the submax running phase of the general warm-up phase. In the dynamic stretching phase, motor unit activation and synchronization, its relationship with the running technique components, and stretch-shortening cycle mechanism gains can be achieved. In the activation part, it is known that a suitable physiological basis for performance in neuronal, neuromuscular, and intramuscular mechanisms of sprint performance is provided (26). The times at which the activated physiological processes achieve peak performance and then return to baseline differ. The motion forms applied in dynamic stretching can positively affect the locomotor mechanism needed during running.

Another potential mechanism for dynamic stretching to increase performance is post-activation potentiation (PAP). The moderate intensity of the movement patterns, especially for the lower extremity, during dynamic stretching creates a PAP effect through contraction and stretching in the antagonist's muscles to be used before the sprint. Performance improvement after PAP has been reported to be related to improved motor unit excitability (30), increased motor unit involvement and synchronization, decreased presynaptic inhibition, or greater central activation of motor neurons (31). On the other hand, PAP-induced phosphorylation in myosin contributes to an increase in the prolongation-shortening cycle rate (31). As a result of this study, it is known that the time interval where the PAP effect provides the highest gain is 8-12 minutes, among the possible reasons for higher sprint performance in BGW (32). General warm-up and transition phase time intervals of 5 minutes after dynamic stretching may have brought the participants closer to the 'maximum effect time interval'. Another possible mechanism may be that general warm-up increases the metabolism and intramuscular temperature of muscle groups whose activation is increased by movements similar to running mechanics in dynamic stretching through warm-up running.

Another important factor is the increase in core and intramuscular temperature during the warm-up period. The increase in muscle temperature after warm-up causes an increase in performance in power and speed-based sports (33). Studies have shown that the temperature of the vastus lateralis muscle increased by ~3 degrees after dynamic stretching and a 15-minute sprint-based warm-up (33). Especially after the general warm-up period, the core temperature increase continues gradually, reaching its peak in ~ 10 minutes (34). The increase in performance seen in BGW, the gradual increase in the heat gain provided by dynamic stretching, and the gradual increase in general warming may have improved other physiological mechanisms associated with sprint performance.

Limitation

In the study's experimental design, applying a 20-meter sprint performance test without warming up could have helped better understand the subject. However, it could not be performed considering the risk of injury (35).

CONCLUSION

The study showed that dynamic stretching before the general warm-up affected the 20-meter sprint performance more positively than AGW. Athletic performance coaches and coaches should experience which warm-up strategy their athletes respond better to achieve higher performance in sprint-based training and competitions. In future research, studies designed with a test-retest experimental approach and physiology-based studies are needed to understand the gains obtained. Furthermore, only 20 meters sprint performance was performed in this study. Considering the dynamics of a soccer game, it should be noted that it will have different factors that should be clarified in future studies.

Conflicts of interest

The authors declare no conflict of interest.

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